Childhood Malnutrition In Rural Egypt: Results of the Ministry of Health's "Weighing Exercise"

Health Care Delivery Systems Project: Monograph #4

By
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M.I.T. - Cairo University Health Care Delivery Systems Project

Monograph # 4

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PREFACE

This monograph is one in a series of studies being prepared by the M.I.T.-Cairo University Health Care Delivery Systems Project, a collaborative research venture featuring scholars at the two schools in association with senior officials in Egypt's Ministry of Health.[1]

Since its inception in May 1977, the project has examined health care delivery in relation to malnutrition, morbidity, infant and early childhood mortality, and fertility. This has entailed two types of inquiry, the data for which have been collected, converted into machine-readable form, and analyzed (in part) to date.

One line of inquiry consists of computer-based analysis of governorate data concerning infant mortality, the birth rate, various demographic and developmental indices, and characteristics of the health system. This work examines the interaction between infant mortality and fertility in Egypt and attempts to identify the effects that different modes of development have on each. Also probed are the independent impact of health interventions on infant births and deaths, the circumstances conditioning popular utilization of health services, and problems of "reporting bias" in the data. This research locates the malnutrition-mortality-fertility

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[1] The Health project is one of fourteen projects sponsored by the Cairo University - M.I.T. Technological Planning Program. This program was established in 1977 with funding from the United States Agency for International Development for the purpose of bringing Egyptian and American scholars together in policy-oriented research intended to assist the government of Egypt.

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dynamic in its socio-economic context and then illuminates the critical linkages and causal patterns involved.[2]

The second line of inquiry is the one relevant to this monograph. It entailed design of a Health System Questionnaire and its distribution to a national sample of 132 rural health centers and units (one per district in the 17 rural governorates of Lower and Upper Egypt).[3] The questionnaire, which was administered by the Ministry of Health in March - April 1978, solicits three types of information, as follows:

> Part I: perceptions, beliefs, attitudes, and reported procedures on a range of issues, with the head doctor of each facility being the principal respondent. Topics include health problems encountered, how these problems are dealt with, use of scales and growth charts, the allocation of supplementary foods, experience with family planning, feelings about rural people, difficulties experienced, and overall job satisfaction.
>
> Part II: data routinely recorded at the center/unit level organized into new categories, disaggregations, and combinations in order to make these data more informative and serviceable. Topics include births and birth supervision, childhood deaths and their attributed causes, utilization rates, recorded child weights, and immunizations.
>
> Part III: data on nutritional status generated by a two-week exercise of weighing more than 4,000 children in a subsample of health centers (one per governorate), along with an assessment of the exercise by those responsible for executing it.

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2 See John Osgood Field and George Ropes, "Infant Mortality, the Birth Rate, and Development in Egypt," M.I.T. - Cairo University Health Care Delivery Systems Project, Monograph #1 (May 1980), and "The Influence of the Health System on the Recorded Incidence of Infant Mortality and Birth Rates in Rural Egypt," M.I.T. - Cairo University Health Care Delivery Systems Project, Monograph #2 (June 1980).

3 Omitted were the four urban governorates of Cairo, Alexandria, Port Said, and Suez owing to the Ministry's administrative separation of rural and urban services. Also omitted were the four sparsely populated "frontier" governorates.

Part I seeks to define how health care is delivered at the periphery of the health system, where contact with the public takes place. Part II assesses the utility of existing data collected at the local level for problem identification, program planning, and monitoring. Part III has two purposes: to test the feasibility of making nutritional surveillance an on-going activity of the rural health service, and to generate new growth data for comparison with the perceptions and existing records already secured in Parts I and II. The questionnaire in its entirety constitutes the principal concern of the Health Care Delivery Systems Project and should also emerge as the project's principal contribution to the Ministry of Health. The Ministry, in turn, deserves principal credit for successful implementation of the questionnaire in all its parts.

This monograph addresses the weighing exercise of Part III. It examines the growth performance of small children in rural Egypt, assesses the strengths and limitations of the exercise, and compares the findings generated with those of other studies in Egypt and with data from elsewhere. Because high levels of malnutrition are documented by the weighing exercise, although with significant variation from place to place, it is especially interesting to weigh the results obtained against those of the national nutrition survey, which was also completed in the spring of 1978. Other monographs based on the Health System Questionnaire deal with the surveillance of child growth, with

family planning, and with supplementary feeding.[4] In addition, the project has produced a Reference Manual containing distributions along with regional and governorate breakdowns of the data derived from the questionnaire.[5]

Mohamed el Lozy, the principal author of this study, is an Assistant Professor in the Department of Nutrition at the Harvard School of Public Health. John Osgood Field, Associate Professor of Nutrition and Political Science at Tufts University, is also a Research Associate in M.I.T.'s Center for International Studies. George Ropes is a doctoral candidate in the Department of Political Science at M.I.T. Robert Burkhardt is a doctoral candidate in M.I.T.'s Department of Economics. All four authors wish to acknowledge the many contributions of their counterparts at Cairo University and in the Ministry of Health in making this analysis possible.

John Osgood Field
June 24, 1980

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4 See John Osgood Field and George Ropes, "Monitoring Malnutrition in Rural Egypt: Opportunities and Constraints," M.I.T. - Cairo University Health Care Delivery Systems Project, Monograph #7 (forthcoming); Robert Burkhardt, John Osgood Field, and George Ropes, "Family Planning in Rural Egypt: A View from the Health System," M.I.T. - Cairo University Health Care Delivery Systems Project, Monograph #6 (June 1980); Robert Burkhardt, John Osgood Field, and George Ropes, "Supplementary Feeding in Rural Egypt: A Summary Profile of the Health System in Action," M.I.T. - Cairo University Health Care Delivery Systems Project, Monograph #5 (June 1980).

5 "Results of the Health System Questionnaire Administered by the Ministry of Health, Arab Republic of Egypt, at 132 Rural Health Centers and Units, March - April 1978: A Reference Manual," M.I.T. - Cairo University Health Care Delivery Systems Project, Monograph #3 (May 1980).

1. INTRODUCTION

Malnutrition is among the most pervasive and serious health problems in the world today. Protein-energy malnutrition, in particular, results in physical stunting of the very young, impaired learning, possibly even irreversible brain damage, and -- of course -- high rates of infant and early childhood mortality. An indicator of under-development, extensive malnutrition is also believed by many to be a barrier to development, for it constrains human competence and productivity, inhibits a society's capacity for change, and serves as a powerful disincentive to the practice of family planning. Malnutrition does much to lock people into the very state of deprivation from which it is derived. Just as malnutrition is a key ingredient of the poverty syndrome, combating malnutrition is probably a necessary, if not a sufficient, condition for breaking out of it.

Measurement of the extent of malnutrition in a society is a difficult task. While a variety of direct and indirect methods are available,[1] one method that is now widely used measures the growth of preschool-age children, who are considered to be the group most affected by nutritional deprivation. Numerous programs, most local but some national in scope, do this regularily.[2] These programs

1. A very thorough, if somewhat old, study of the problem is found in Jelliffe, D. B., The Assessment of the Nutritional Status in the Community, Geneva, World Health Organization Monograph Series # 53, 1966.

usually have one of two major objectives: either they aim at discovering individuals at risk, for purposes of treating them,[3] or they aim at monitoring the status of the communities in which these individuals live, thereby acting as an early warning system to detect regional or national nutritional emergencies before they occur.[4]

This report deals with a weighing exercise which was carried out in April 1978 on a sample of 4,327 children in 17 rural health centers and units, one selected at random from each of the rural governorates of Lower and Upper Egypt. The weighing exercise comprised Part III of the Health System Questionnaire developed by the M.I.T. - Cairo University Health Care Delivery Systems Project[5], the first

2. Among the national programs is Operation Timbang ("Weighing") in the Philippines. See Solon, F. S. "Nutrition and Government Policy in the Philippines", In: Winikoff, B. (editor) Nutrition and National Policy, Cambridge, MIT Press, 1978, pp 233-290. See also National Nutrition Council and Nutrition Center of the Philippines, "The Philippine Nutrition Program, 1975-1976", 1975, 49 pp.

3. See, for example, Morley, D. "The design and use of weight charts in surveillance of the individual" In: Beaton, G. H. and Bengoa, J. M. (editors) Nutrition in Preventive Medicine, Geneva, World Health Organization, 1976, pp 520-529. On the other hand, it should be noted that McLaren has been very critical of the entire "under fives clinics" concept (McLaren, D. S. Transactions of the Royal Society of Tropical Medicine and Hygiene 68: 260 - 261, 1974).

4. For a detailed discussion of the latter aspect, often referred to as "Nutritional Surveillance", see Methodology of Nutritional Surveillance, Report of a Joint FAO/UNICEF/WHO Expert Committee, Geneva, World Health Organization Technical Report Series # 593, 1976.

5. The Health System Questionnaire was jointly developed by

two parts of which were administered to the doctors in 132 health facilities, or one per district.

The first part of the questionnaire included questions on the doctors' perceptions of the nature of the major diseases they encountered, as well as their impressions of the severity and importance of nutritional disease in the areas served by their units. The second part of the questionnaire solicited information from the Maternal and Child Health (MCH) records at sampled facilities concerning the incidence of weighing and the actual weights recorded. It seemed logical to try to compare both the doctors' perceptions and the existing records with objective new results, both for a better understanding of the workings of the system and in order to provide feedback to the participating doctors.

Furthermore, we believed it desirable to document from within the health care delivery system, not from outside it, the nature and extent of nutritional problems in the country. Doing so would test the operational feasibility of growth surveillance and would help determine whether something of the kind might be incorporated into the normal routine of the rural health system.[6] Such an approach, if

M.I.T., Cairo University and the Ministry of Health. It was administered in the field by the Ministry of Health.

6. The feasibility of monitoring child growth on a regular basis will be addressed in a future monograph, tentatively titled Monitoring Malnutrition in Rural Egypt: Opportunities and Constraints being prepared by

generalized and accompanied by proper reporting to Cairo, would serve as an early warning mechanism to detect adverse changes as they occur, and would also provide a clear means of monitoring the effects of policies soon after their implementation.[7]

The exercise was followed by a questionnaire (Part IIIB of the study) filled out by the unit doctors at the termination of the exercise. This questionnaire included questions on the ease of carrying out the measurements of weight and height, on the cooperation of the public, on specific problems encountered, and finally the question: "Based on your center/unit's experience with the exercise, how true do you think the following statement is? Weighing children at regular intervals can be incorporated into the center/unit's routine without much difficulty." It was hoped that the exercise would allow all concerned, especially the Ministry of Health, to evaluate the practical feasibility of an anthropometric nutrition surveillance program.

This monograph presents the results of the weighing exercise, assesess its strengths and weaknesses, and compares its findings with those of other studies, both in

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the M.I.T. - Cairo University Health Care Delivery Systems Project.

7. A related objective of the weighing exercise was to provide a learning experience for rural health personnel responsible for child welfare, the monitoring of child growth being a casual and intermittent activity at best in most rural health centers and units at the present time.

Egypt and elsewhere. As originally conceived, the weighing exercise was intended to be a test of feasibility, not a scientific inquiry, but its substantive results are difficult to ignore, if only because they document a high incidence of malnutrition among small children in rural Egypt.

2. DATA COLLECTION

For obvious logistic reasons only a small sub-sample of the health units which had participated in the other two parts of the study could be used, and it was decided to select, at random, one unit from each governorate.

A training course lasting two days was held at Cairo University in March 1978 for the physicians and nurses from the 17 centers participating in the weighing exercise. Measuring tapes and scales were provided, and demonstrations of the correct techniques for weighing and measuring height were given. Sources of error were explained, as were the steps to avoid them. The exercise itself was conducted over a two-week period at each participating facility. The target was to obtain weights and (for children aged two or more) heights on 250 children in each unit, distributed equally between the two sexes and the first five annual age cohorts. Children below one year were weighed when they came to the unit for vaccination or health care during that two-week period. Children aged one to five were "called",

with birth registers used for identification.

Infants were weighed on UNICEF scales. Older children were weighed on adult scales specially provided for the occasion, children's scales being available neither at the sampled facilities nor in the market.

3. DATA PROCESSING

In the units the data were initially recorded on sheets, with one line per child, on which a serial ID, sex, date of birth (from unit registers) and weight (together with height, when measured) were recorded. These sheets were sent to Cairo, where they were trancribed onto coding forms, key-punched, and transferred to magnetic tape. One copy of that tape was kept in Cairo and used by the Cairo University group, while the other was sent to M.I.T. The latter tape, with several children per card image, was run through a computer program to generate one card image per child. At the same time, ages were computed from the date of birth and kno. date of measurement.

As the next step, the weights and heights (when available) were expressed as percentages of the National Center for Health Statistics (NCHS) medians[8] and as standard deviation scores.[9] The percentages of median and standard

8. Hamill, P. V. V., Drizd, T. A., Johnson, C. L., Reed, R. B., Roche, A. F. and Moore, W. M. American Journal of Clinical Nutrition 32: 607 - 629, 1979.

deviation scores, together with the age and sex of each child, were then made into an SPSS[10] system file used in all subsequent work.

In all analyses, we excluded extreme data values, presumed to represent errors of measurement or of coding. Our criteria were to exclude subjects with a weight of less than 45% or more than 135% of the standard for the subject's age, a height below 60% or above 115% of standard for age, or finally with a weight below 65% or above 155% of standard for the subject's height. Subjects whose values for any of the three anthropometric variables were out of range were excluded from all subsequent analyses. This led to the exculusion of about 5% of the sample. The choice of these criteria is discussed in Appendix A.

4. RESULTS

The principal finding of the study is clear: Malnutrition, as measured by growth failure, is extensive among the children examined.

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9. This was done using a series of programs written by James B. Goldsby at the Preventable Diseases and Nutrition Activity, Center for Disease Control, Atlanta, Georgia. We are most grateful to him for making these programs available to us.

10. Nie, N. H., Hull, C. H., Jenkins, J. G., Steinbrenner, K. and Bent, D. H. SPSS: Statistical Package for the Social Sciences, second edition, New York, McGraw-Hill, 1975.

a. Only 40% may be considered normal in weight-for-age using the Gomez classification. Five percent revealed third degree malnutrition.

b. Chronic malnutrition (height-for-age under 90% of standard) characterizes 40% of the children over age two, of whom almost half showed more serious stunting.

c. Weight-for-height measurements reveal 6% of the children to be acutely undernourished (<80% of standard). Obesity was a problem for 14% of the children.

d. On the Waterlow classification, 39% of the children over age two were stunted, 4% wasted, and 1% both stunted and wasted.

The main results, giving the percent of children in different nutritional categories, are presented in Tables 1 to 4 broken down by governorate and aggregated into Lower Egypt, Upper Egypt and total sample. In carrying out the computations for the aggregates, the data were weighted by the governorate population proportion. It will be noted that the number of subjects in the tables involving height is smaller than in those indicating weight alone, since height was not measured in children who could not stand.

Here and elsewhere we will often use the word "governorate" to describe the governorate in which a particular unit is located. Unfortunately, because the weighing exer-

cise was experimental, only one unit was sampled per governorate, so there is no way of knowing whether the differences between the units reflect real differences between governorates or merely reflect differences between villages. In statistical jargon, we say that the village and governorate effects have been confounded.

We have followed the Nutrition Institute of Egypt/Center for Disease Control (NI/CDC) study[11] in expressing our results in four forms:[12]

1). On the basis of weight-for-age, recording the distribution of subjects by Gomez class,[13] based on weight as a percentage of the NCHS[14] median for that age. The Gomez categories are normal (90% or more of standard), first degree malnutrition (75 to 89.9% of standard), second degree

11. Nutrition Institute, Ministry of Health, Arab Republic of Egypt, Arab Republic of Egypt. Nutrition Status Survey, 1978. April, 1979.

12. See Waterlow, J. C. "Classification and definition of protein-energy malnutrition" In: Beaton, G. H. and Bengoa, J. M. (editors) Nutrition in Preventive Medicine, Geneva, World Health Organization, 1976, pp 530-555 for a thorough discussion of the topic.

13. Gomez, F., Galvan, R. R., Frenk, S., Chavez, R. and Vazquez, J. Journal of Tropical Pediatrics 2: 77-83, 1956.

14. This description is not really accurate, as Gomez et al clearly stated that their categories were based on the Harvard growth standards (Stuart, H. C. and Stevenson, S. S. In Nelson, W. E. (editor) Textbook of Pediatrics 7th edition, Saunders, Philadelphia, 1959, pp 12 - 61. The differences between the Stuart and NCHS standards are so slight that the practical effect of using one rather than the other is nil.

malnutrition (60 to 74.9% of standard) and third degree (below 60% of standard).

2). On the basis of height-for-age, considering subjects with heights below 90% of the NCHS medians as being "chronically malnourished",[15] and those 90% or above as "normal" by this criterion. Each of these two classes was further subdivided; the normals being divided into those above and below 95% of standard and the chronically malnourished into those above and below 85%.

3). On the basis of weight as a percentage of that appropriate for the child's height. Subjects below 80% of the NCHS standard were described as "acutely malnourished",[16] those 120% or above were described as "obese", while those in between were described as "normal". The latter group was split into two; those below and those above 100% of standard.

4). On the basis of weight-for-height and height-for-age examined together.[17] Both variables were dichotomized, the dividing level being 80% for weight and 90% for height.

15. Waterlow (loc. cit) prefers the term "stunted", which is merely descriptive, to the more loaded term "chronically malnourished".

16. Again, Waterlow prefers the descriptive term "wasted" to "acutely malnourished".

17. This approach was suggested by Waterlow, J. C. and Rutishauser, I. H. E. "Malnutrition in man". In Cravioto, J. (editor) Early Malnutrition and Mental Development. Uppsala, Almqvist & Wiksells, 1974, pp 13-26.

This gives a two by two cross-classification, those with weights and heights both above the dividing point being considered normal, those with normal weights but low heights as stunted, those with normal heights and low weights as wasted, and finally those with both weights and heights low as stunted and wasted.[18]

Table 1 gives the proportion of children in each of the Gomez classes by governorate, demonstrating the wide range of nutritional status observed. The percentage of children with "normal" weights (90% or more of standard) varies from a low of 3.9% in Sharkia to a high of 70.3% in Kafr-el-Sheik, and the proportion of children with third degree malnutrition varies from none in Behera to 24.5% in Sharkia.[19] The weighted average for third degree malnutrition is 7.0% for Lower Egypt, 3.3% for Upper Egypt and 5.4% for the entire country. It must be noted that, in addition to Shar-

18. In doing so, we have followed common practice. The World Health Organization suggests dividing each of height and weight into four categories, based on standard deviation scores, and presenting the result in a four by four table, with 16 entries (Waterlow, J. C., Buzina, R., Keller, W., Lane, J. M., Nichaman, M. Z. and Tanner, J. M. Bulletin of the World Health Organization 55: 489-498, 1977). Neither standard deviation scores nor the reporting of results in the form of four by four tables is widely used at present.

19. As noted above, we are using the name of the governorates in which the units are located as a paraphrase for correct, but unwieldy, expressions. The above sentence should be interpreted to mean "... from a low of 3.9% in the unit situated in Sharkia to a high of 70.3% in the unit located in Kafr-el-Sheik .... At no point do we, or indeed can we, make any inferences about differences between governorates.

kia, both Damietta (14.0%) and Kalyubia (13.4%) have an incidence of third degree malnutrition higher than 10%.

Aggregating second and third degree malnutrition, we get a nationwide incidence of 23.6% (28% in Lower Egypt and 18.1% in Upper Egypt). That is to say, in our total sample about one child in four is either moderately or severely malnourished as judged by his weight.[20]

Table 2 gives the proportions of children in different height-for-age categories. Again we see wide variability. While in the whole sample 69.9% of the children fall into the "normal" category, the range is from a low of 31.3% in Sharkia to a high of 78.1% in Ismailia. Similarily, while the overall incidence of severe chronic undernutrition is 17.1% (19.8% in Lower and 13.9% in Upper Egypt) it ranges from none in Kafr-el-Sheik to 52.8% in Sharkia, which is again closely followed by Damietta (50.0%) and Kalyubia (44.8%). On the whole, physical stunting emerges as a common occurrence among pre-school children in rural Egypt.

Table 3 shows the subjects categorized by their weights relative to their heights. Assuming that weights below 80% of the standard for height denote "acute undernutrition", 6.1% of the children in the total sample are acutely

20. This is almost exactly the incidence found in Central America by INCAP in 1965-67 (Table 5 in Behar, M. "Appraisal of the nutritional status of population groups, IN: Beaton, G. H. and Bengoa, J. M. Nutrition in Preventive Medicine pp 556-575, Geneva, World Health Organization, 1976).

undernourished. Here again the range is enormous, from none in Kalyubia and Behera to 30.4% in Damietta, closely followed by Sharkia (27.0%).

Table 4 shows the subjects categorized by both weight-for-height and height-for-age, using the Waterlow classification. We note that 22.2% of the sample (26.4% in Lower and 17.0% in Upper Egypt) fall into the most severe classification: stunting and wasting. Here the proportions range from a low of 2.8% in Kafr-el-Sheik to a high of 67.4% found in both Damietta and Sharkia.

In addition, we have computed mean values for weight-for-age, height-for-age and weight-for-height for the whole sample, and for each unit, for each sex separately and for the sexes combined. Figures 1 and 2 show the mean growth curves for the whole sample plotted on the NCHS standard curves. It will be noted that, for the first nine months or so, our sample does not differ too much from the American norms: the girls actually follow the median curve while the boys wander between the twenty-fifth and fiftieth centiles. After that age there is a pronounced drop, with the curves always below the twenty-fifth centile and often dipping below the fifth.

Figure 3 shows the proportion of boys and girls in each of the Gomez classes according to their ages (using unweighted figures). The incidence of third degree malnu-

trition is clearly higher in the boys and for both sexes reaches its peak during the second year of life.[21] Table 5 aggregates second and third degree malnutrition and shows that their joint incidence remains between 25 and 30% in boys over the first four years, dropping to 16.7% in the fifth year. The incidence in girls is lower and shows no clear age trend. It also shows more year to year variability.

Many further tabulations, based on breaking the population down by age, sex and the groupings of governorates that form the "universes" of the NI/CDC study are presented in Appendix B.

For the purpose of assessing the individual effects of location, sex and age an analysis of variance was performed on the three variables: weight-for-age, height-for-age and weight-for-height, each expressed as a percentage of the NCHS standards. The independent variables were sex, governorate and, in the case of weight-for-age, age group (0 to 6 months, 7 to 24 months, 25 months and above). We did not use the age group variable for the other two anthropometric variables, as few subjects below 24 months had their heights recorded.

21. Jelliffe has noted that, in traditional societies, the peak period of nutritional risk is during the transitional or weaning period, most often during the second year of life. He has suggested using the term secotrant (from second year transitional) for children in their second year of life (Jelliffe, D. B. Journal of Pediatrics 74: 808 - 810, 1969).

As is clear from the range of values found in Tables 1 to 4, the analysis shows significant differences between "governorates" (really between units, as noted above) for all three variables. It would appear that nutritional status varies considerably across the villages of rural Egypt. Age groups have a highly significant effect on weight-for-age, the only dependent variable where this effect could be tested, the youngest age group (0 to 6 months) having the highest values and the second group (7 to 24 months) the lowest. Sex had a significant effect only on weight-for-age, with the girls having the higher values, as might be expected from Table 5.[22]

This study has demonstrated that there are large differences in how the children of different villages grow. While those in some of the study villages grow well, others do not, and in the aggregate their growth was not satisfactory. The overall incidence of malnutrition found is high, and more disturbing is the incidence of severe malnutrition, especially in the 6 - 24 month cohort.

22. This finding does contradict the conventional wisdom that girls, being less desired than boys, are taken less good care of and hence fare more poorly. Shukry et al found no sex differences in Saft el Laban, and in Manshaat el Bakary they found, as we did, a slightly lower incidence of malnutrition in girls than in boys. The NI/CDC study does not give any sex breakdowns.

5. DISCUSSION

Table 6 compares the incidence of malnutrition, as judged by each of the four criteria used, reported in the current survey and by the NI/CDC survey. Given the professionalism of the that study, one is entitled to wonder how good the present results are. We believe that our results are a reasonable approximation of the truth, and furthermore we do not believe that they err in the direction of overstating the incidence of malnutrition. This conclusion was reached (1) by studying the details of the procedures used, looking for sources of bias; (2) from evidence of internal consistency; and (3) from comparisons between our results and other studies in Egypt and elsewhere.

There are two potential sources of error in our procedure: errors of sampling and errors of measurement. Under the first heading, our choice of villages was obtained by random sampling of one health unit from each governorate. While the units selected may be unrepresentative at both governorate and national levels, there is no way of knowing whether and to what extent this is so without fairly detailed information on them. The general presumption is that a randomly selected sample is representative until proven otherwise, and we may assume that this is indeed the case in our study.

The selection of subjects within the selected health

units is less easy to defend. Infants were "self-selected" into our sample by virtue of having been brought to the center/unit while the exercise was in progress. Older children were "called" in annual age cohorts; and while the birth registers include everyone, the "calling" was selective. Most likely, 60 or 70 children of a certain age were called in order to insure weighing at least 50 of them, as per the instructions. But who was called? And who came? We do not know. In the absence of facts it is possible to speculate either that more educated parents, with presumably healthier children, would be more likely to respond, or that, on the contrary, the parents of children who were not thriving, and who were thus in greater contact with the health unit, might be more likely to respond.

We feel that two inferences are likely, though speculative. One is that our sample is biased in favor of children disposed to illness rather than to health. They might be more responsive to a "call" as a result, although the very sick would probably stay home. The second inference is that our sample is biased in favor of children from poorer as against more affluent families, again on the assumption that poorer people are more likely to utilize the government's health services than are the better off. If these inferences are correct, our sample is skewed towards the disadvantaged, which may account for the higher incidence and severity of malnutrition revealed in our data than in the

NI/CDC survey.

We need not apologise for any such biases (if indeed they are present) in our sample. If our sample does under-represent the relatively affluent, in effect it under-represents children who are not prime candidates for malnutrition and mortality. In a sense, statistical representativeness dilutes the seriousness of a problem like malnutrition since one would expect it to be more prevalent and serious among the poor. By focusing more on the poor, who are numerous enough, we may be tapping the real magnitude of the problem where it exists. Moreover, the fact that our sample is disposed towards use of the health system is a practical advantage. What we have documented is extensive malnutrition among children with whom the health system is already in contact. Our children are clients in fact as in need. They are, therefore, reachable with little effort required. Viable solutions (oral rehydration, supplementary feeding, and the like) should follow.[23]

The second area of doubt concerns the accuracy of measurement and of age estimation. There is no doubt that our measurers were not as well trained as those employed in the

23. The Ministry of Health's experience with supplementary feeding in rural Egypt is reviewed by Allen, S. R. and Koval, A. J., Food Aid for Supplementary Feeding: A Case Study From Egypt and in Burkhardt, R., Field, J. O. and Ropes, G. Supplementary Feeding in Rural Egypt: A Summary Profile of the Health System in Action, M.I.T. - Cairo University Health Care Delivery Systems Project, Monograph # 5 (June 1980).

NI/CDC study. Furthermore, while that study went to great effort to obtain accurate ages, our study took the ages from the birth records. Beginning with the last point, birth records will systematically underestimate the age of a child as his parents can delay registration after his birth, but obviously cannot register him before birth![24] Since we used ages that underestimate the true ages, we were comparing our subjects to standards for younger children, making them appear less malnourished than they really were. Hence this bias clearly acts in the direction of our underestimating the prevalence of malnutrition, not of overestimating it.

It might be argued that the very high incidence of low weights in Sharkia could be due to a systematic error, such as improperly zeroed scales. However, as noted above, Sharkia, Damietta and Kalyubia had the highest incidences of both low weight and short stature, and it is difficult to conceive that, in those three units, both the scales and the measuring rods were biased, and in the same direction. Figures 4 to 6 demonstrate the extent to which height and weight were correlated in the 17 study sites. Figure 4 is a plot of the percentage of children with severe weight defi-

24. The effect of using ages derived from birth certificates is discussed by el Lozy, M. American Journal of Clinical Nutrition 29: 585-590, 1976. In a population where the true incidence of third degree malnutrition is 5%, we would expect the frequency observed, using ages based on birth certificates, to be between 3 and 4% (depending on the average delay in birth registration) in the 2-5 years group. Larger discrepancies would be found in younger children.

cits (below 60% of standard) against those with severe height deficits (below 85% of standard). The correlation between the two is extremely high, being 0.934. Not only are heights and weights measured with different instruments, but weights were measured in all the children, heights only in those able to stand. Hence we can conclude that the differences in mean measurements between villages are not due to biased measuring instruments.

Figure 5 is similar to Figure 4 but shows the correlation between the proportion of children with adequate heights and the corresponding figure for weights. While the correlation is smaller, it is still 0.713. Finally, Figure 6 shows the correlation between mean heights and weights expressed as a percent of standard, and we have a satisfactory correlation of 0.653. These three figures all convey the same message: the marked differences in mean weights in the study units are correlated to similar differences in mean heights. This makes it most unlikely that they represent the effects of non-random (biased) measurement error.

While we are confident that there were no consistent systematic errors, we are aware of the considerable amount of random error introduced by inadequately trained measurers (Appendix A). One effect of random errors is to inflate both tails of the distribution,[25] in other words to increase

25. The variability of any observed variable, say weight,

the incidence of both underweight and overweight, at the expense of the central group. The fact that our survey shows a higher prevalence of both overweight and underweight (judged on the basis of weight-for-height) than the NI/CDC study (13.8% versus 3.1% for overweight and 6.1 % versus 0.6 % for acute malnutrition) does suggest that this phenomenon is occurring.[26] Unfortunately, there is no way of quantitating this effect without making many arbitrary assumptions.[27]

In addition to the evidence internal to our study presented above, there is the evidence from other studies

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has two components: the true variability and the variability introduced by measurement. An important statistical result is that the observed variance (the square of the standard deviation) is the sum of the true variance and the variance of the measurement (see, for example, Kreyszig, E. Introductory Mathematical Statistics New York, Wiley, 1970, pp137-138). Hence increasing the measurement error, even if the errors are random and unbiased, will increase the observed variance.

26. It should be noted that this effect is not seen to such an extent in the weight-for-age and height-for-age variables (see Appendix C). Furthermore, we show in that appendix that the difference in incidence of severe malnutrition in the two studies is not due solely to differences in variances (where one might a priori assume the NI/CDC results to be closer to the truth) but also due to lower mean values found in our study.

27. In Appendix C we make an admittedly speculative attempt to account for our presumedly excessive observed variance. On the basis of what we feel is the most reasonable set of assumptions we estimate the prevalence of third degree malnutrition to be 3.1%, in contrast to the observed prevalence of 5.4%. This still leaves the prevalence much higher than the NI/CDC estimate of 0.8%. Furthermore, there is little change in the estimated incidence of second degree malnutrition, and we are left with an incidence of combined second and third degree malnutrition of around 21% versus the NI/CDC incidence of 9%.

carried out in Egypt over the years. A number of studies in Egypt show an incidence of severe protein-energy malnutrition (weight-for-age of less than 60% of standard) much closer to our overall mean than to the NI/CDC figures. This is shown in Table 7. Two weaknesses of these studies, like our own, may be that they are not as random as they claim and that their quality control is suspect. On the other hand, they have the advantage of being fairly in-depth analyses of children in particular villages, and it may just be that the more you look, the more you find, as in the case of childhood mortality.[28] The NI/CDC survey may have covered rural Egypt well, but it weighed only 30 children in any one site. Our weighing exercise, like the village studies, is notable for its depth in specific places.

Similarly, Table 8 shows the incidence of malnutrition as reported in the Central American countries by INCAP in the period 1965-67,[29] compared with the figures obtained by us and by the NI/CDC. We have added columns giving the infant mortality rates at the time of these studies[30] and

28. See Field, J. O. and Ropes, G., The Influence of the Health System on the Recorded Incidence of Infant Mortality and Birth Rates in Rural Egypt, M.I.T. - Cairo University Health Care Delivery Systems Project, Monograph # 2 (June 1980).

29. Behar, loc. cit.

30. For the Central American studies we used data for 1966 (Statistical Office of the United Nations, Demographic Yearbook, 1968, New York, United Nations, 1969, p. 368), while those for Egypt are for 1978 (personal communication from Dr. Almotaz Mobarak)

the Physical Quality of Life Index (PQLI)[31] for these countries. The only Central American country with an infant mortality rate similar to that found in Egypt is Guatemala, and it is interesting to note that Guatemala possesses an incidence of severe malnutrition similar to that which we found. None of the Central American countries show an incidence of third degree malnutrition as low as that reported by the NI/CDC, not even Panama with a reported infant mortality rate half of that found in Egypt. Indeed, our own "deflated" figures (Appendix C) would suggest an incidence of malnutrition slightly lower than the average of the six Central American countries, each of which has a lower infant mortality rate than Egypt.[32] This suggests that our deflation is, if anything, excessive.[33] Looking at the

31. The PQLI is a composite index of developmental progress, based on life expectancy, infant mortality and literacy. It attempts to measure how well societies satisy certain specific life-serving social characteristics (Morris D. Morris, Measuring the Condition of the World's Poor: The Physical Quality of Life Index New York, Pergammon Press, 1979.)

32. Dr. Joe Wray at the Harvard School of Public Health has suggested that a possible explanation for the lower incidence of malnutrition in Egypt than in the more developed Central America might be related to the fact that Egypt is, at least partially, a wheat eating country, as opposed to the Central American countries which are maize eating. However, if we accept that most of the infant mortality in the developing world is related to malnutrition, it is difficult to explain how a country with a low incidence of malnutrition (as the NI/CDC survey claims that Egypt is) could have so high an infant mortality rate.

33. The very high correlation obtained between the proportion of children with severe weight and height deficits (Figure 5) further reinforces our feeling that the tails are not as inflated as might be expected on

more global PQLI,[34] we again find that Costa Rica and Panama, with PQLIs double Egypt's, still have a higher incidence of third degree malnutrition than that reported by the NI/CDC.

6. CONCLUSION

While readily acknowledging the defects of our study, we do not believe that the malnutrition uncovered by it is all, or even largely, an artifact. The figures we have obtained are internally coherent, and they accord well with the accumulated experience in field of childhood malnutrition in Egypt. While we are unwilling to give a precise numerical estimate of the size of the problem, it is clearly not trivial.

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the basis of the undeniablly excessive random measurement error.

34. It is not strictly legitimate to compare the PQLIs as all were computed using data for the early 1970s, while the nutrition surveys in Central America were conducted between 1965 and 1967. Nevertheless, we feel that they do show an extra dimension of the relative development of the countries concerned.

TABLE 1

Weight for Age Percentage Distribution
of Egyptian Preschool Children
by Gomez Classification of Nutrition Status

Percent of NCHS/CDC Reference Median

	Normal 90.0+	1° 75.0-89.9	2° 60.0-74.9	3° <60.0	(N)
Damietta	14.0	22.6	49.5	14.0	(186)
Dakahlia	48.5	41.4	9.3	.9	(227)
Sharkia	3.9	20.1	51.5	24.5	(229)
Kalyubia	39.3	28.6	18.7	13.4	(224)
Kafr-el-Sheik	70.3	21.8	6.7	1.3	(239)
Gharbia	26.0	46.3	22.8	4.9	(246)
Menufia	32.0	50.8	16.0	1.2	(244)
Behera	56.2	34.7	9.1	0	(121)
Ismailia	50.9	40.5	8.1	.5	(222)
Giza	53.2	37.4	8.3	1.1	(265)
Beni-Suef	30.4	45.4	20.1	4.0	(273)
Fayoum	41.2	43.3	13.5	2.0	(245)
Minya	54.8	30.9	10.0	4.3	(230)
Assiut	27.7	41.8	23.8	6.6	(256)
Souhag	40.4	38.0	17.8	3.8	(366)
Kena	51.8	36.3	10.6	1.3	(226)
Aswan	28.8	40.7	25.6	4.9	(285)
Lower Egypt	37.1	34.8	21.0	7.0	(1,938)
Upper Egypt	43.7	38.2	14.8	3.3	(2,146)
Sample	40.0	36.3	18.2	5.4	(4,084)

Note: The percentage figures add to 100% horizontally (discrepancies due to rounding). Those for the governorates are unweighted. Those for Lower and Upper Egypt and for the sample as a whole are weighted by governorate population proportions. In these latter instances, the actual number of children surveyed is given in parentheses.

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TABLE 2
Height for Age Percentage Distribution
and Prevalence of Chronic Undernutrition
in Egyptian Preschool Children

Percent of NCHS/CDC Reference Median

	Chronic Undernutrition		Normal		
	<85.0	85.0-89.9	90.0-94.9	95.0+	(N)
Damietta	50.0	19.6	17.4	13.0	(92)
Dakahlia	11.0	26.8	35.4	26.8	(127)
Sharkia	52.8	15.7	20.2	11.2	(89)
Kalyubia	44.8	16.8	21.6	16.8	(125)
Kafr-el-Sheik	0	9.7	21.5	68.7	(144)
Gharbia	16.3	29.3	36.1	18.4	(147)
Menufia	10.5	30.1	42.0	17.5	(143)
Behera	7.0	35.2	39.4	18.3	(71)
Ismailia	8.1	13.8	42.3	35.8	(123)
Giza	6.7	17.4	31.5	44.3	(149)
Beni-Suef	10.6	29.8	41.8	17.7	(141)
Fayoum	11.0	17.1	26.0	45.9	(146)
Minya	17.5	18.3	34.1	30.2	(126)
Assiut	28.5	38.0	22.8	10.8	(158)
Souhag	9.5	20.7	31.4	38.5	(169)
Kena	12.3	10.9	34.1	42.8	(138)
Aswan	13.4	18.0	31.4	37.2	(172)
Lower Egypt	19.8	24.4	31.9	23.9	(1,061)
Upper Egypt	13.9	21.0	31.3	33.8	(1,199)
Sample	17.1	22.9	31.6	28.3	(2,260)

Note: The percentage figures add to 100% horizontally (discrepancies due to rounding). Those for the governorates are unweighted. Those for Lower and Upper Egypt and for the sample as a whole are weighted by governorate population proportions. In these latter instances, the actual number of children surveyed is given in parentheses.

TABLE 3

Weight for Height Percentage Distribution
and Prevalence of Acute Undernutrition and Obesity
in Egyptian Preschool Children

	Percent of NCHS/CDC Reference Median				
	Acute Undernutrition	Normal		Obese	
	<80.0	80.0-99.9	100.0-119.9	120.0+	(N)
Damietta	30.4	42.4	3.3	23.9	(92)
Dakahlia	2.3	28.9	53.9	14.8	(128)
Sharkia	27.0	69.7	2.2	1.1	(89)
Kalyubia	4.8	28.8	41.6	24.8	(125)
Kafr-el-Sheik	0	29.2	58.3	12.5	(144)
Gharbia	4.8	36.1	45.6	13.6	(147)
Menufia	.7	52.4	41.3	5.6	(143)
Behera	0	31.0	32.4	36.6	(71)
Ismailia	1.6	46.3	45.5	6.5	(123)
Giza	2.0	42.7	41.3	14.0	(150)
Beni-Suef	11.2	51.3	34.9	2.6	(152)
Fayoum	4.8	56.2	35.6	3.4	(146)
Minya	4.6	29.8	44.3	21.4	(131)
Assiut	5.7	38.0	37.3	19.0	(158)
Souhag	13.6	61.5	22.5	2.4	(169)
Kena	2.2	39.1	55.8	2.9	(138)
Aswan	18.6	54.7	23.3	3.5	(172)
Lower Egypt	5.9	38.7	38.7	16.7	(1,062)
Upper Egypt	6.3	44.3	39.0	10.4	(1,216)
Sample	6.1	41.3	38.8	13.8	(2,278)

Note: The percentage figures add to 100% horizontally (discrepancies due to rounding). Those for the governorates are unweighted. Those for Lower and Upper Egypt and for the sample as a whole are weighted by governorate population proportions. In these latter instances, the actual number of children surveyed is given in parentheses.

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TABLE 4

Percentage Distribution of Egyptian Preschool Children: Waterlow Classes by Governorate

	Normal	Wasting	Stunting	Wasting & Stunting	(N)
Damietta	13.0	17.4	56.5	13.0	(92)
Dakahlia	60.6	1.6	37.8	0	(127)
Sharkia	10.1	21.3	62.9	5.6	(89)
Kalyubia	35.2	3.2	60.0	1.6	(125)
Kafr-el-Sheik	90.3	0	9.7	0	(144)
Gharbia	51.0	3.4	44.2	1.4	(147)
Menufia	58.7	0.7	40.6	0	(143)
Behera	57.7	0	42.3	0	(71)
Ismailia	76.4	1.6	22.0	0	(123)
Giza	74.5	1.3	24.2	0	(149)
Beni-Suef	56.0	3.5	39.7	0.7	(141)
Fayoum	67.8	4.1	27.4	0.7	(146)
Minya	64.3	0	34.9	0.8	(126)
Assiut	29.7	3.8	64.6	1.9	(158)
Souhag	60.4	9.5	26.0	4.1	(169)
Kena	76.1	0.7	21.7	1.4	(138)
Aswan	51.7	16.9	29.7	1.7	(172)
Lower Egypt	51.4	4.3	42.7	1.5	(1,061)
Upper Egypt	61.4	3.7	33.6	1.4	(1,199)
Sample	55.9	4.0	38.6	1.4	(2,260)

Note: The percentage figures add to 100% horizontally (discrepancies due to rounding). Those for the governorates are unweighted. Those for Lower and Upper Egypt and for the sample as a whole are weighted by governorate population proportions. In these latter instances, the actual number of children surveyed is given in parentheses.

Table 5: Combined Prevalence (Percent) of Second and Third Degree Malnutrition, by Age and Sex

Age group	Boys	Girls
First year	26.3	17.5
Second year	30.0	24.1
Third year	24.9	18.8
Fourth year	28.7	26.0
Fifth year	16.7	19.7

Table 6: Comparison of the Extent of Malnutrition Revealed by the MIT/CU/MOH and NI/CDC Surveys, Using Various Indicators.

Indicator	MIT/CU/MOH	NI/CDC
Gomez 3rd degree	5.4	0.8
Severe chronic undernutrition	17.1	4.5
Acute undernutrition	6.1	0.6
Wasting and stunting	22.2	0.3

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TABLE 7

The Incidence of Third Degree Malnutrition (Weight-for-Age) in Several Studies: Egypt

Place	% 3rd Degree	Attributes	Source
Saft El-Laban	15.4	Males 0-72 months (N=377)	Shukry et al.[1]
	15.4	Females 0-72 (N=370)	" " "
Manshaat El-Bakary	7.0	Females 0-72 (N=713)	" " "
	6.7	Males 0-72 (N=781)	" " "
Baragil	7.9	Both 12-24 months (N=41)	Badran et al.[2]
	11.7	Both 24-36 (N=34)	" "
	0	Both 36-60+ (N=125)	" "
"Urban"	6.0	Both 0-72 months (N=507)	Abdou[3]
17 centers/units	5.8	Males 0-60 (N=2,222)	MIT-CU-MOH
	4.4	Females 0-60 (N=1,862)	" "
Sanhour	3	Both 0-72 months (N=437)	Hekmat & Ghoneme[4]
Ein El-Sira & Giza MCH centers	2.8	Both 12 months + (N=?)	Kamel & El-Rafie[5]
Edfou area	2	Both 0-72 months (N=223)	Hekmat et al.[6]
Rural sample	0.7	Both 6-71 months (N=5,336)	N.I.-C.D.C.

1 A.S. Shukry et al., "An Epidemiological Study of Protein-Calorie Malnutrition Among Rural Population in Egypt," Gazette of the Egyptian Paediatric Association, 20 (March 1972), p. 155.

2 Ibrahim Badran et al., "Community Development Project of Baragil Village: Medical Report," Cairo University monograph (September 1976), p.7. A high incidence of edema is also reported in this study.

3 I.A. Abdou (1970), cited in M.R. Barrakat, "Current Information on Nutritional Problems in the Middle East," paper presented at the International Conference on Practical Approaches to Combat Malnutrition with Special Reference to Mothers and Children, Cairo, May 25-29, 1977, p. 11.

TABLE 7 (Continued)

4

Hekmat E. Aly and Farouk M. Ghoneme, "The Nutritional Status of Preschool Children in Sanhour Village as Evidenced by their Anthropometric Measurements," manuscript (1975), p. 6.

5

Laila M. Kamel and Mervat El-Rafie, "Maternal and Child Health Status in a Slum Area," paper presented at the First Medical Research Conference, Alexandria (August 1975), p. 5.

6

Hekmat E. Aly et al., "The Nutritional Status of Preschool Children in Edfou," undated manuscript, p. 7.

Table 8: Infant mortality rate (IMR), physical quality of life index (PQLI) and prevalence of malnutrition in Egypt and in certain Central American countries.

Country	IMR	PQLI	Percent of subjects with malnutrition			
			Total	1st degree	2nd degree	3rd degree
Costa Rica	69.9	85	57.4	43.7	12.2	1.5
El Salvador	62.0	64	74.5	48.5	22.9	3.1
Guatemala	91.5	54	81.4	49.0	26.5	5.9
Honduras	37.8	51	72.5	43.0	27.2	2.3
Nicaragua	55.4	54	56.8	41.8	13.2	1.8
Panama	45.0	80	60.7	48.8	10.8	1.1
Central America			71.4	46.7	21.3	3.4
Egypt (NI/CDC)	96.0	43	47.3	38.5	8.0	0.8
Egypt (Present study)			60.0	36.3	18.2	5.4
Above, deflated			59.0	38.0	18.0	3.1

NOTE: The infant mortality rates and incidence of malnutrition for the Central American countries are for 1966,[1] while for Egypt they refer to 1978.[2] The PQLI figures all refer to the early 1970s.[3]

1. IMR from Statistical Office of the United Nations, Demographic Yearbook, 1968 New York, United Nations, 1969, p. 368, and the incidence of malnutrition from Behar, loc. cit.

2. The IMR figures are from Dr. Almotaz Mobarak (personnal communication) and represent the average of the 1977 and 1979 figures.

3. Morris, loc. cit.

FIGURE 1

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Boys: Birth to 36 Months; Average Weight
(Weighted), Rural Egypt
Physical Growth
NCHS Percentiles

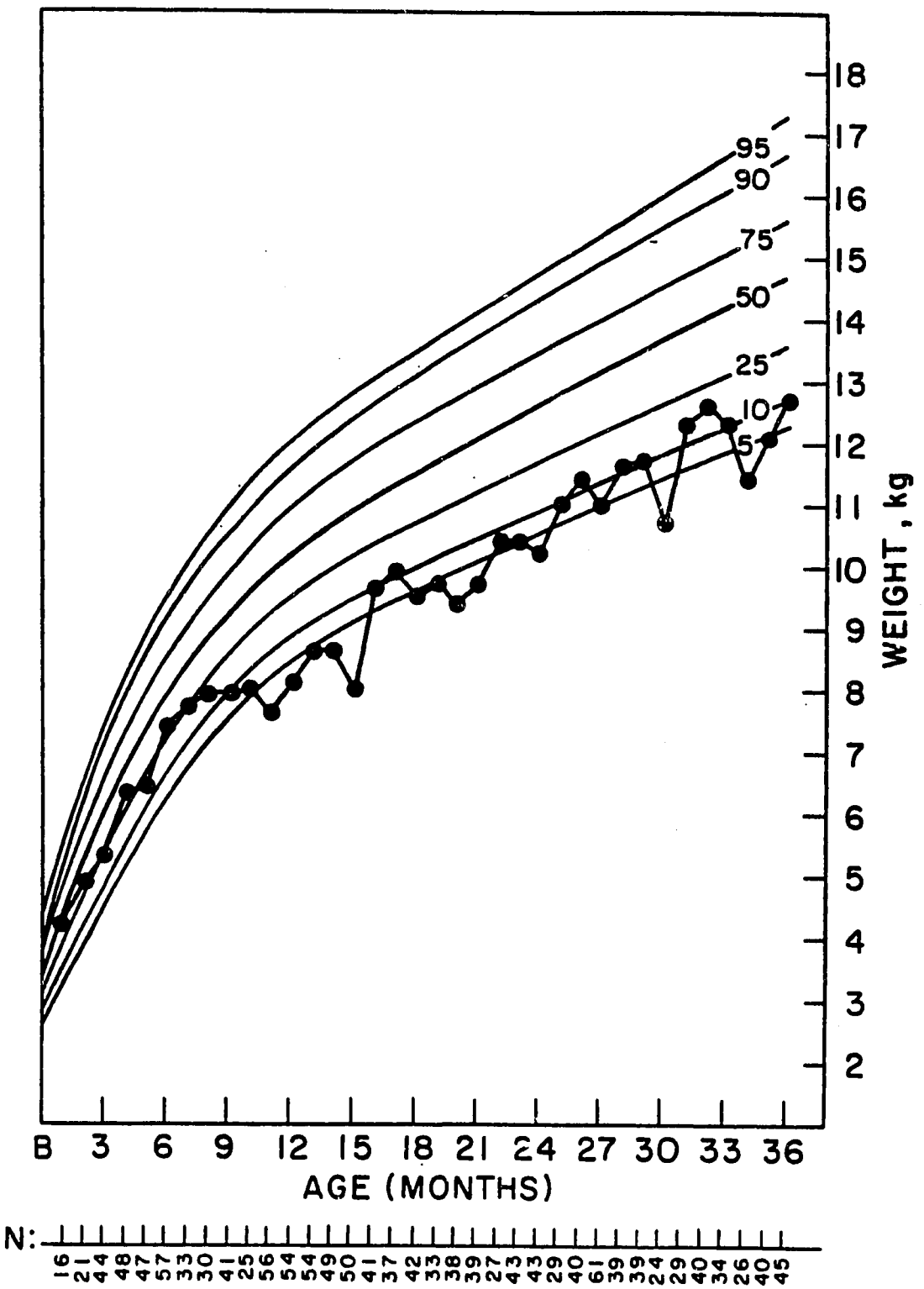

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FIGURE 2

MIT - Cairo University Health Care Delivery Systems Project
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Girls: Birth to 36 Months; Average Weight
(Weighted), Rural Egypt
Physical Growth
NCHS Percentiles

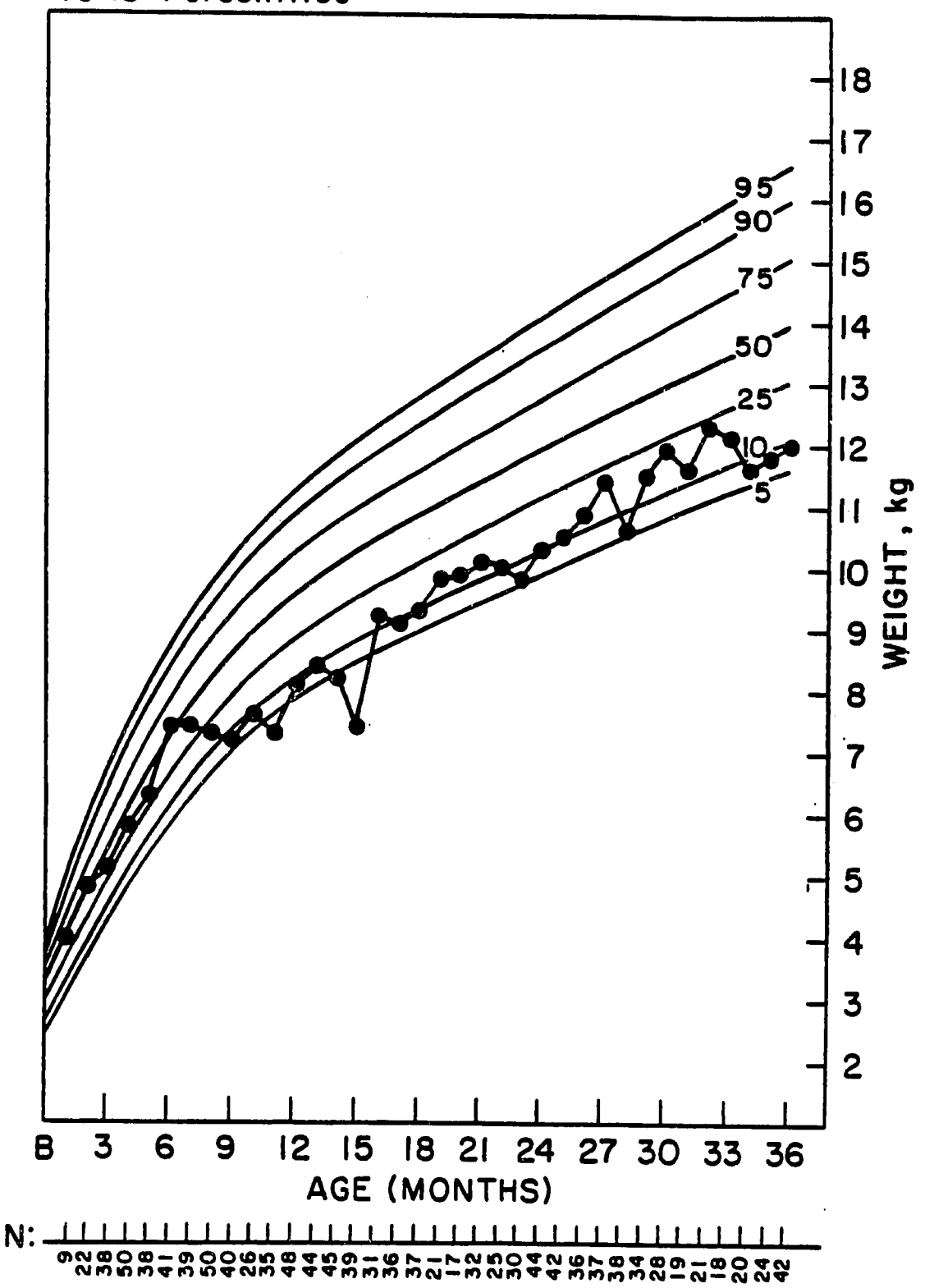

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FIGURE 3

DISTRIBUTION OF NUTRITIONAL STATUS (GOMEZ CLASSIFICATION) BY AGE AND SEX

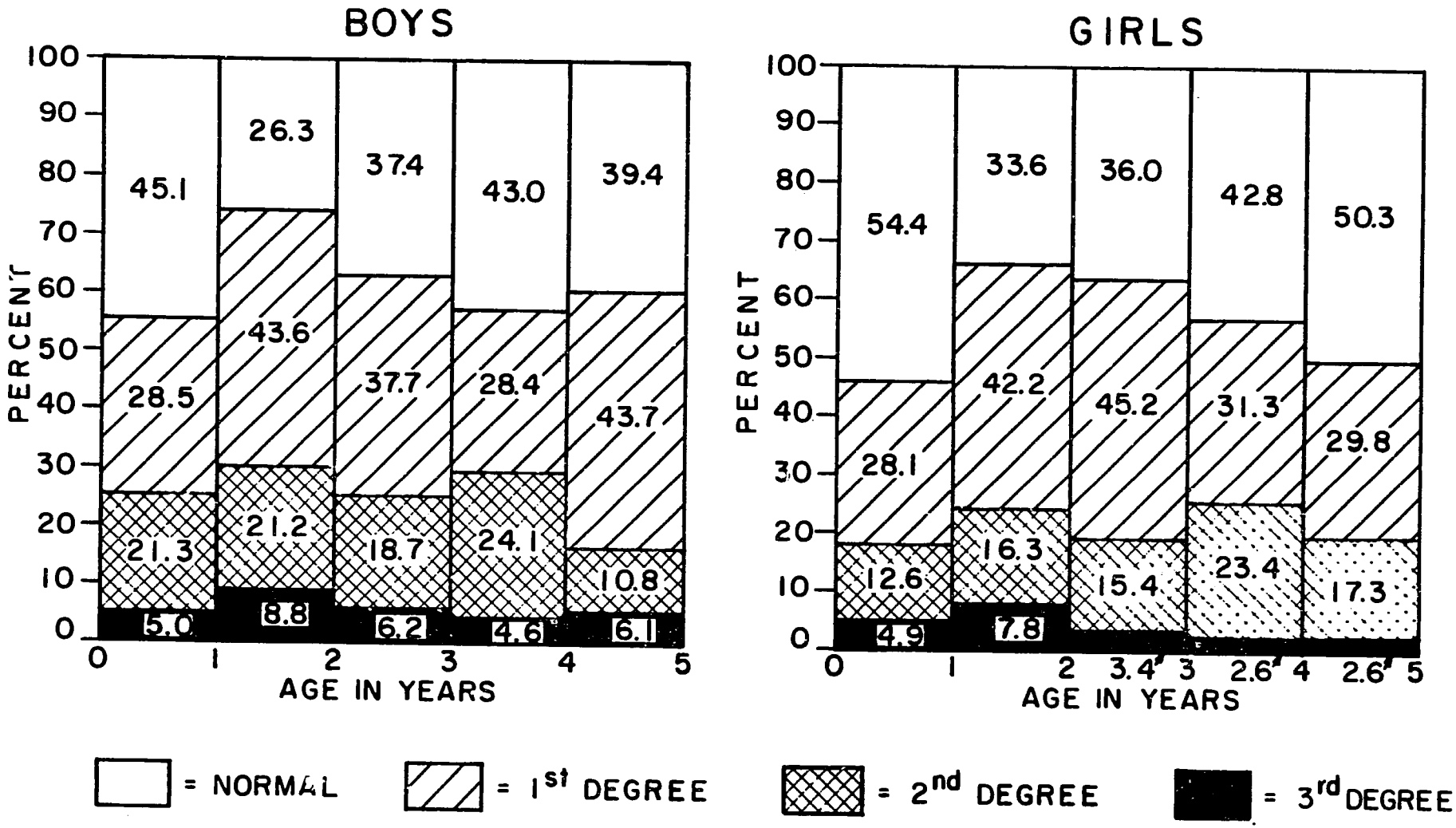


Figure 4. Relation between proportion of children with severe weight and height deficits in the 17 governorates.

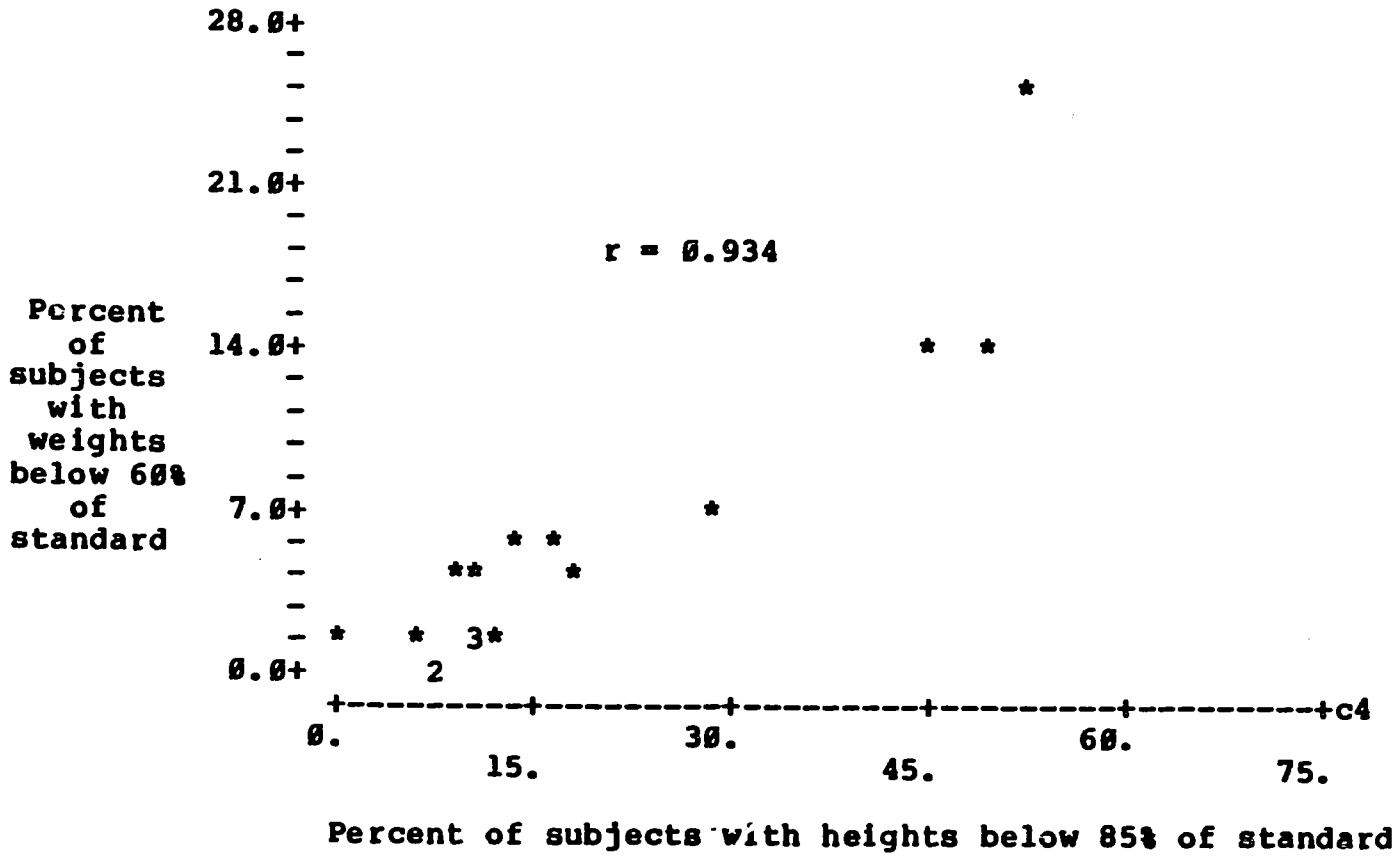


Figure 5. Relation between the proportion of children having "adequate" heights and weights in the 17 governorates.

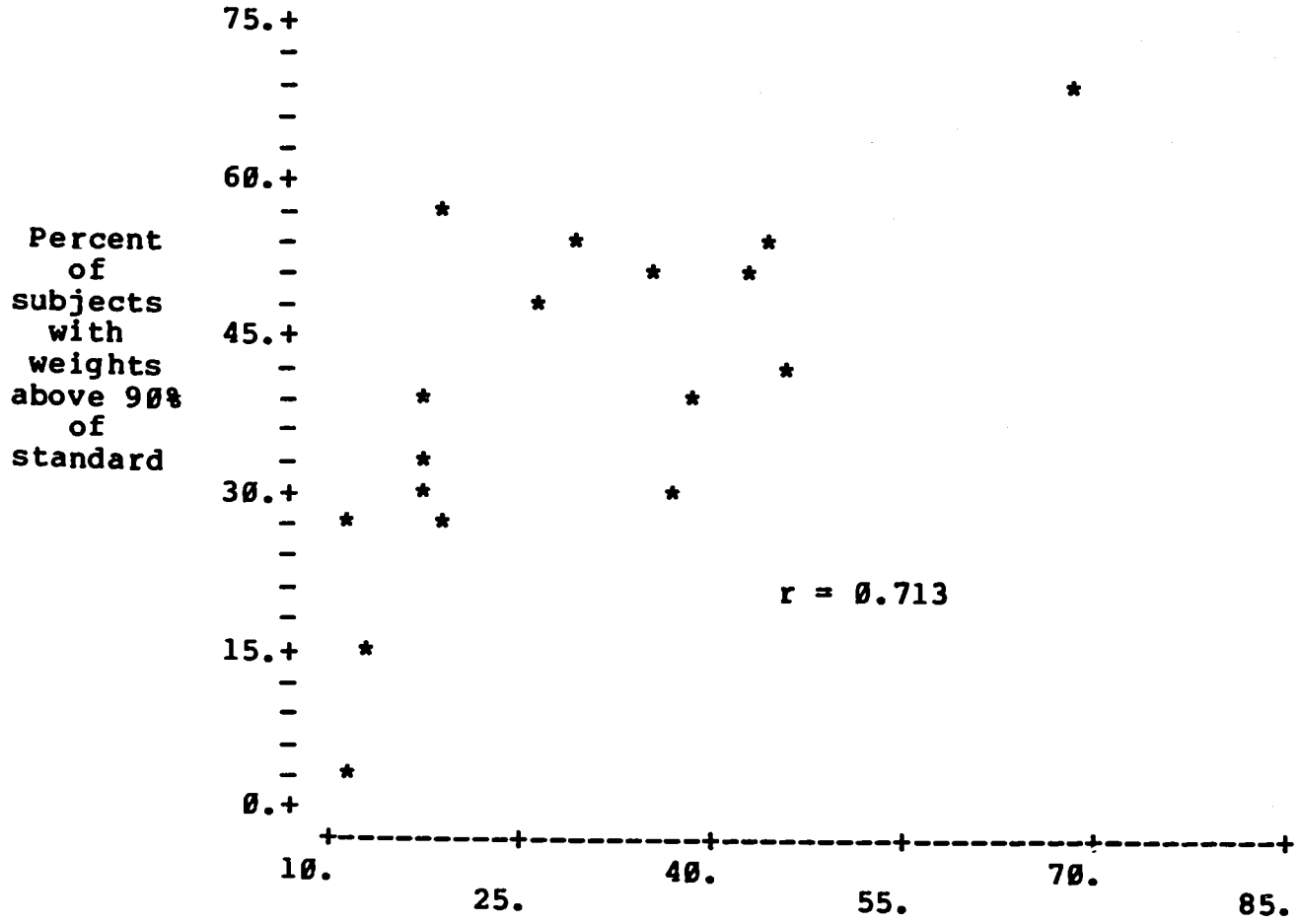
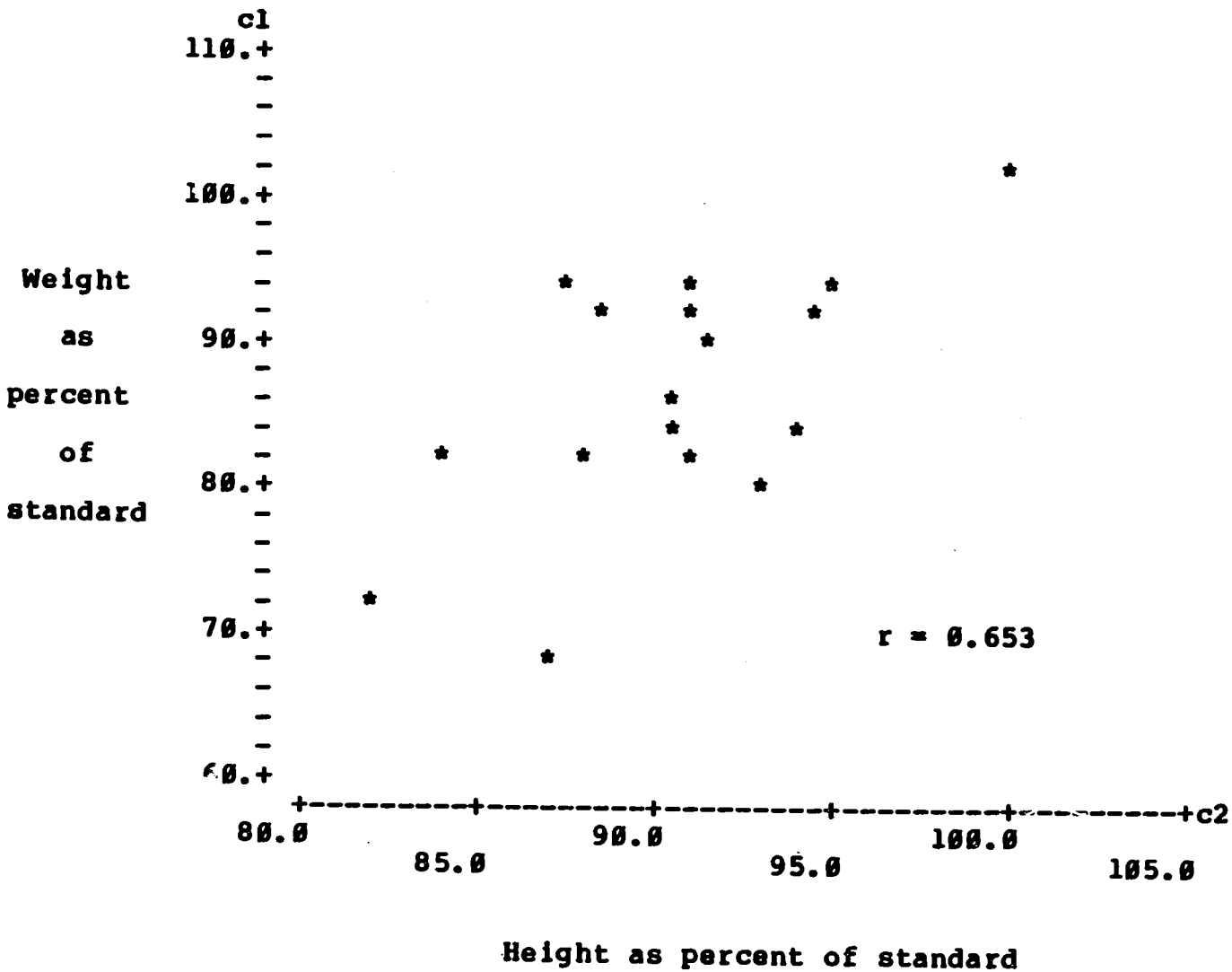


Figure 6. Relation between mean weight and mean height (both expressed as percent of standard) in the 17 governorates.



Appendix A: Data Cleaning Procedures

As a rapid check on the care with which the data had been collected, the frequency with which the integers 0 to 9 occurred as last digits of the weight was computed for each unit. Table A1 shows that none of the units fared well on that test, most having rounded almost all the data to the nearest kg, in spite of instructions to measure to the nearest 100 g. Furthermore, it was noted that some units seemed to have long runs of children all weighing 10.0kg. In addition, some of the extreme values recorded were clearly wrong. Hence, some kind of data cleaning procedure was an essential prelude to any meaningful analysis.

The selection of a procedure to "clean" data that are obviously in need of cleaning is always to a certain degree arbitrary, depending in the final analysis on the judgement of the investigator. Methods used are rarely deemed worth publishing, so no body of shared experience can accumulate. In our case the procedures used deserve careful examination, as they involved cutting off extreme values, while the main focus of our study was precisely on the incidence of extreme (low) values.

Something clearly had to be done, as a few obviously impossible results had been recorded. In an attempt to find clear cut-off points, separating the really extreme children

from the obvious errors, we discretized the weight-for-age, height-for-age and weight-for-height, all expressed as percentages of the NCHS medians, and examined the frequencies of the different classes.

The result of this effort was disappointing. In the height-for-age variable there was no long tail of presumably suspect results. Instead we had a beautiful bell-shaped curve, beautiful except for the fact that it ranged from 13 standard deviations below standard to 8 above! We had great difficulty in selecting meaningful cut-off points here, and placed them so as to exclude the terminal, smallest groups. These limits excluded cases with heights below 60% of standard or above 115%, and in retrospect it seems that they may have been too wide. In the case of weight-for-age we had the same problem at the lower tail, and selected 45% as the cut-off point. At the long upper tail we placed the cut-off point at 135% of standard.

For both of these variables we could suspect errors in either measurement or in age recording. The third variable, weight-for-height, is one that has been proposed as an "age-independent" anthropometric measurement. Improbable results here could only reflect measurement errors, and quite a few were indeed found. In spite of the lack of a break in the values recorded, we had a reasonably clear distinction between the central hump of the distribution and

the tails and had little difficulty in putting our limits at 65% and 155% of standard.

Table A2 shows, for each unit, the number of cases excluded due to an unacceptable value for each of the three variables. The totals range from 1.2% of the sample in the unit from Fayoum to 10.1% in the unit from Kafr-el-Sheik, with an overall average of 5%.

Discussion of Cleaning

It is almost impossible to justify the particular cut-off points that we used, and it is equally difficult to suggest a more defensible procedure. We deliberately avoided one approach that might have, on superficial examination, looked better. That would have involved, for each unit, obtaining an estimate of the variance from the interquartile range, uncontaminated by outliers. Using the median as a robust estimator of the mean, we might then have calculated, on the assumption of normality, the number of children with weights and heights below specified levels. Assumptions of normality can often be applied confidently to estimates of mean values, but it is most dangereous to apply such assumptions when dealing with the tails, as we are in this study.

Table A 1: Frequencies of last digits of weights by center/unit.

Center/ Unit #	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Digit																	
0	102	186	33	233	252	220	210	92	162	275	147	172	242	243	268	137	209
1	7	2	46	0	0	0	0	1	2	0	0	0	0	0	9	0	1
2	14	14	42	0	0	0	0	6	2	0	0	0	0	0	13	0	0
3	9	15	47	0	0	6	0	1	7	0	23	17	0	0	4	3	4
4	5	1	11	0	0	0	0	2	0	0	0	1	0	0	3	0	0
5	18	20	30	12	15	20	35	10	44	7	05	37	9	21	64	112	81
6	4	4	2	0	0	0	0	4	8	0	0	5	0	0	3	0	0
7	11	0	4	0	0	0	0	2	1	0	0	0	0	0	10	0	0
8	15	7	23	1	0	9	0	7	6	0	10	17	0	0	13	0	1
9	11	1	2	1	0	0	0	2	2	0	0	1	1	0	2	0	0

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TABLE A2

Weighing Exercise: Number of Children Weighed and the Incidence of Outliers

	Total Number of Children Weighed	OUTLIERS Total N	(%)	Wt/Age	Ht/Age	Wt/Ht
Damietta	199	13	(6.5)	4	2	8
Dakahlia	250	24	(9.6)	5	1	20
Sharkia	240	11	(4.6)	6	0	7
Kalyubia	249	21	(8.4)	8	5	14
Kafr-el-Sheik	268	27	(10.1)	20	12	4
Gharbia	255	6	(2.4)	1	0	5
Menufia	245	1	(0.4)	1	0	1
Behera	127	3	(2.4)	3	0	0
Ismailia	234	8	(3.4)	1	0	7
Giza	282	11	(3.9)	9	3	2
Beni-Suef	275	13	(4.7)	2	0	12
Fayoum	250	3	(1.2)	2	2	0
Minya	252	23	(9.1)	12	1	11
Assiut	264	7	(2.7)	4	0	4
Souhag	389	18	(4.6)	14	3	2
Kena	252	22	(8.7)	17	8	3
Aswan	296	6	(2.0)	1	1	5
Lower Egypt	2,067	114	(5.5)	49	20	66
Upper Egypt	2,260	103	(4.6)	61	18	39
Sample	4,327	217	(5.0)	110	38	105

Appendix B: Additional Results

This appendix gives, without comment, several further tables patterned after those of the NI/CDC study.

Tables B1 to B4 present the data in the same four forms as in Tables 1 to 4, but broken down on the basis of age groups, 0 to 5 months, 6 to 11 months, and then yearly groupings. Finally, Table B5 gives the incidence of acute malnutrition, short stature and obesity broken down by sex and by age group.

The Nutrition Institute/CDC study aggregated certain groups of governorates into what they call "universes" as follows:

Universe 1: Damietta, Kafr-el-Sheikh
Universe 2: Ismailia, Sharkia
Universe 3: Dakahlia, Gharbia, Menufia, Kalyubia
Universe 4: Behera
Universe 5: Giza, Fayoum, Beni-Suef, Minia
Universe 6: Assiut, Souhag, Kena, Aswan

Tables B6 to B9 repeat the format of Tables 1 to 4, grouping the units by universes instead of by governorate. This grouping by universes does not seem to be based on any profound similarities (other than geographical proximity)

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and does not seem useful to us. We therefore give these tables for comparison only, with no further comment.

TABLE B1

Weight for Age Percentage Distribution (Gomez Classification)
of Egyptian Preschool Children
by Age Group

Age Group (Months)	Percent of NCHS/CDC Reference Median				
	Normal 90.0+	1° 75.0-89.9	2° 60.0-74.9	3° <60.0	(N)
0-5	55.3	21.4	20.2	3.1	(334)
6-11	45.3	33.2	15.2	6.3	(473)
12-23	29.6	43.0	19.0	8.4	(912)
24-35	36.8	41.1	17.2	4.9	(805)
36-47	42.9	29.7	23.8	3.6	(804)
48-59	42.6	38.7	13.9	4.7	(703)
60	59.6	26.1	11.9	2.4	(53)
Total	40.0	36.3	18.2	5.4	(4,084)

Note: The age groups employed correspond to those appearing in Table 9 (p. 37) of the Arab Republic of Egypt Nutrition Status Survey, 1978. The percentage figures add to 100% horizontally (discrepancies due to rounding). All percentages are weighted by governorate population proportions. The actual number of children surveyed is given in parentheses.

TABLE B2

Height for Age Percentage Distribution
and Prevalence of Chronic Undernutrition
for Egyptian Preschool Children by Age Group

Age Groups (Months)	Percent of NCHS/CDC Reference Median				
	Chronic		Normal		
	<85.0	85.0-89.9	90.0-94.9	95.0+	(N)
24-35	13.0	24.0	34.9	28.0	(706)
36-47	18.3	25.5	31.3	24.9	(800)
48-59	19.5	19.4	29.0	32.1	(701)
60	19.3	18.7	30.3	31.6	(53)
Total	17.1	22.9	31.6	28.3	(2,260)

Note: The age groups employed correspond to those appearing in Table 8 (p. 36) of the Arab Republic of Egypt Nutrition Status Survey, 1978. The percentage figures add to 100% horizontally (discrepancies due to rounding). All percentages are weighted by governorate population proportions. The actual number of children surveyed is given in parentheses.

TABLE B3

Weight for Height Percentage Distribution
and Prevalence of Acute Undernutrition and Obesity
for Egyptian Preschool Children
by Age Group

Percent of NCHS/CDC Reference Median

Age Groups (Months)	Acute	Normal		Obese	
	<80.0	80.0-99.9	100.0-119.9	120.0+	(N)
24-35	7.7	46.3	36.2	9.8	(718)
36-47	7.6	39.7	40.7	12.0	(804)
48-59	3.5	39.2	40.8	16.5	(703)
60	0.9	30.3	25.2	43.7	(53)
Total	6.1	41.3	38.8	13.8	(2,278)

Note: The age groups employed correspond to those appearing in Table 7 (p. 34) of the Arab Republic of Egypt Nutrition Status Survey, 1978. The percentage figures add to 100% horizontally (discrepancies due to rounding). All percentages are weighted by governorate population proportions. The actual number of children surveyed is given in parentheses.

TABLE B4

Percentage Distribution of Egyptian Preschool Children
by Waterlow Classes for Age Groups

Age Groups (Months)	Percentage				
	Normal	Wasting	Stunting	Wasting and Stunting	(N)
24-35	57.5	5.4	36.2	0.8	(706)
36-47	51.1	5.1	41.8	2.1	(800)
48-59	59.3	1.8	37.5	1.4	(701)
60	61.1	0.9	38.1	0	(53)
Total	55.9	4.0	38.6	1.4	(2,260)

Note: The age groups employed correspond to those appearing in Table 10 (p. 38) of the Arab Republic of Egypt Nutrition Status Survey, 1978. The percentage figures add to 100% horizontally (discrepancies due to rounding). All percentages are weighted by governorate population proportions. The actual number of children surveyed is given in parentheses.

TABLE B5

Prevalence of Acute Undernutrition, Obesity, and Short Stature by Sex by Age Group

Percent of NCHS/CDC Reference Median

Age Group (Months)	Sex	Acute Undernutrition Weight/Height <80%	(N)	Obesity Weight/Height >120%	Short Stature Height/Age <90%	(N)
24-35	M	8.3	(401)	8.3	33.3	(395)
	F	6.9	(317)	11.8	41.5	(311)
36-47	M	8.9	(429)	12.1	43.2	(427)
	F	6.0	(375)	11.8	44.5	(373)
48-59	M	3.8	(393)	15.5	37.7	(393)
	F	3.1	(310)	17.7	40.4	(308)
60	M	1.4	(31)	39.6	38.7	(31)
	F	0.0	(22)	50.0	37.1	(22)

Note: The age groups employed correspond to those appearing in Table 26 (p. 79) of the Arab Republic of Egypt Nutrition Status Survey, 1978. All percentages are weighted by governorate population proportions. The actual number of children surveyed is given in parentheses.

TABLE B6

Weight for Age Percentage Distribution
of Egyptian Preschool Children
by Gomez Classifications of Nutrition Status (Weighted)

Percent of NCHS/CDC Reference Median

Populations	Normal 90+	1° 75.0-89.9	2° 60.0-74.9	3° <60.0
Universe 1	54.3	22.0	18.8	4.9
Universe 2	9.5	22.5	46.4	21.6
Universe 3	37.2	42.1	16.2	4.5
Universe 4	56.2	34.7	9.1	0
Universe 5	47.9	37.7	11.6	2.7
Universe 6	38.9	38.9	18.3	4.0
Upper Egypt	43.7	38.2	14.8	3.3
Lower Egypt	37.1	34.8	21.0	7.0
Egypt	40.0	36.3	18.2	5.4

TABLE B7

Height for Age Percentage Distribution
and Prevalence of Chronic Undernutrition
in Egyptian Preschool Children (Weighted)

Populations	Percent of NCHS/CDC Reference Median			
	Chronic Undernutrition		Normal	
	<85	85.0-89.9	90.0-94.9	95.0+
Universe 1	12.3	12.1	20.5	55.1
Universe 2	45.6	15.4	23.8	15.2
Universe 3	18.9	26.2	34.3	20.5
Universe 4	7.0	35.2	39.4	18.3
Universe 5	11.3	19.5	32.9	36.3
Universe 6	16.7	22.7	29.5	31.0
Upper Egypt	13.9	21.0	31.3	33.8
Lower Egypt	19.8	24.4	31.9	23.9
Egypt	17.1	22.9	31.6	28.3

TABLE B8

Weight for Height Percentage Distribution
and Prevalence of Acute Undernutrition and Obesity
in Egyptian Preschool Children (Weighted)

Percent of NCHS/CDC Reference Median

Populations	Acute Undernutrition	Normal		Obese
	<80.0	80.0-99.9	1000.0-119.9	120.0+
Universe 1	7.5	32.4	44.8	15.3
Universe 2	22.9	65.9	9.2	2.0
Universe 3	3.2	35.8	46.6	14.5
Universe 4	0	31.0	32.4	36.6
Universe 5	4.8	42.5	40.2	12.5
Universe 6	8.1	46.4	37.6	7.8
Upper Egypt	6.3	44.3	39.0	10.4
Lower Egypt	5.9	38.7	38.7	16.7
Egypt	6.1	41.3	38.8	13.8

TABLE B9

Percentage Distribution of Egyptian Preschool Children
by Waterlow Classes (Weighted)

Populations	Percentage			
	Normal	Wasting	Stunting	Wasting & Stunting
Universe 1	67.3	8.3	5.8	18.7
Universe 2	13.4	25.5	2.9	58.2
Universe 3	47.2	7.6	22.9	22.3
Universe 4	56.3	1.4	22.5	19.7
Universe 5	60.1	9.0	19.2	11.7
Universe 6	44.7	15.9	16.4	23.0
Upper Egypt	52.8	12.3	17.9	17.0
Lower Egypt	46.6	9.2	17.8	26.4
Egypt	49.4	10.5	17.8	22.2

Appendix C: The Actual Incidence of Malnutrition: A Speculative Estimate

We realize that our results are contaminated by measurement error, and as noted in the text even unbiased measurement error will increase the variance, leading to inflation of the tails of the distribution. Hence we believe that our estimate of the incidence of third degree malnutrition is probably too high. In this appendix we attempt to obtain a more accurate estimate, with the clear realization that the number of assumptions required makes this exercise somewhat speculative.

If we had an estimate of the variance of the measurement error it would be simple to subtract it from the observed variance, obtaing an estimate of the population variance. Since we have no such estimate, we are forced to proceed in a circuitous fashion, trying to obtain, from our figures and those of the NI/CDC, a reasonable estimate of the true variance. We do this for only one of the variables, namely weight-for-age, as this is the variable on which the commonest classification of malnutrition, that of Gomez, is based. Furthermore, the weight-for-height variable is inherently more error-prone, being based on two measurements, each with its error.

The NI/CDC monograph does not present any results in

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the form of means and standard deviations. In Appendix 8, however, frequency distributions are given for height-for-age, weight-for-age and weight-for-height in standard deviation units, and from these distributions means and standard deviations can be calculated. Table C1 compares the values obtained in the two surveys. The mean values of both weight-for-age and height-for-age obtained in our survey are substantially lower (by about half a standard deviation) than those found by the NI/CDC survey. Since we feel that there is no reason to suspect our measurers of making systematic (biased) errors, that implies that the children in the sample we examined were in fact smaller than those in the NI/CDC sample.

As expected, we have larger standard deviations for all three variables, due at least in part to our less well-trained measurers. In the case of weight-for-age our standard deviation (1.49 standard units) is about 32% greater than that obtained by the NI/CDC (1.13 units). We are somewhat sceptical of the latter value, finding it smaller than seems reasonable. The process of constructing the standard scores is such that the standard deviation of the reference population is one. Given the far greater environmental heterogeneity in Egypt as compared with the United States, we feel that it is unlikely that the standard deviation of an Egyptian sample would be only 13% greater than that of the reference population. On the other hand we know that

our value (49% greater than the reference population) is inflated by measurement error. Taking the mean of these two values and rounding it to 30% seems to us to give a reasonable estimate of the true excess variability of the Egyptian samples. Hence we estimate the standard deviation of the sample to be 1.3 units. If we accept that value our standard deviation is about 1.15 times too large; if we accept the NI/CDC value it is 1.32 times too large.

With this information in hand we can now estimate the incidence of the various degrees of malnutrition in our population. For our entire sample the weight-for-age as percent of standard has a mean value of 86.8 and a standard deviation of 16.53. The skewness (0.2) and kurtosis (-0.1) are both small enough for us to treat the sample as normal.

In Table C2 we give the results of computing[1] the pro-

1. An example will clarify the computational procedure. To compute the proportion of children with third degree malnutrition (weight-for-age below 60% of standard) using the observed standard deviation we subtract 60 from 86.8 (the mean) and divide the result by 16.53 (the standard deviation) obtaing a value of 1.62. Hence 60% of standard corresponds to a value 1.62 standard deviations below the mean, and the proportion of a normal population more than 1.62 standard deviations below the mean is found from tables of the normal distribution to be 5.3%. Hence 5.3% of the population has a weight of less than 60% of the standard. A similar computation shows that 75% of standard corresponds to (86.8 - 75)/16.53 or 0.71 standard deviations below the mean, and 23.9% of a normal population falls below that value. The proportion of subjects with weights between 60% and 75% of standard (second degree malnutrition) is thus 23.9% minus 5.3%, or 18.6%. All entries in the table were computed in a similar fashion.

portion of children in each of the Gomez classes using the observed mean value of the weight-for-age as a percent of standard with three different standard deviations: (1) 16.53, the observed standard deviation, (2) 12.53, the observed standard deviation divided by 1.32, deflating it to the level of variability observed in the NI/CDC survey and (3) 14.39, using the compromise deflator. In addition the table gives the proportion of children actually found in each of the categories by both surveys.

The first point to note is the close correspondence between the proportion of children found by us in each class and the results computed using the mean and the observed standard deviation. This, together with the small values found for both skewness and kurtosis, suggests that the assumption of a normally distributed population is not unreasonable.

The second point to note is the marked effect of deflation on the proportion of children with third degree malnutrition. Using undeflated figures the estimated proportion is 5.3%, using the compromise deflator reduces the proportion to 3.1%, while deflating to the level of the NI/CDC study further reduces it to 1.6%. On the other hand deflation has a much smaller effect on the combined prevalence of second and third degree malnutrition, the proportions being 23.9%, 21.1% and 17.3% for the three estimates. The smallest of these three is still almost twice as large as the

prevalence found in the NI/CDC survey (8.8%).

The computations described above are based on a large number of untestable assumptions. Nevertheless they clearly demonstrate that the substantial differences in the incidence of combined second and third degree malnutrition between this study and the NI/CDC study cannot be ascribed to an inflation of the tails by measurement error.

Table C1: Means and Standard Deviations (in Standard Deviation Units) of Anthropometric Variables in the NI/CDC and MIT/CU/MOH Studies

	NI/CDC		MIT/CU/MOH	
Variable	mean	std. dev.	mean	std. dev.
Weight-for-age	-0.87	1.13	-1.23	1.49
Height-for-age	-1.63	1.26	-2.03	1.63
Weight-for-height	0.18	0.96	0.12	1.49

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Table C2: Observed and Computed Distribution of Children in Different Gomez Classes

Gomez Class	Observed		Calculated using std. dev. of		
	NI/CDC	MIT/CU/MOH	16.5	14.3	12.5
Normal	52.7	40.0	42.2	40.9	40.0
First degree	38.5	36.3	33.9	38.0	42.7
Second degree	8.0	18.2	18.6	18.0	15.7
Third degree	0.8	5.4	5.3	3.1	1.6

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